PROGRAMMABLE PRECISION SHUNT REGULATOR TL431/A/C

FEATURES

- Programmable Output Voltage to 40V
- Guaranteed 0.5% Reference Voltage Tolerance
- Low (0.2Ω Typ.) Dynamic Output Impedance
- Cathode Current Range(Continuous) – 100 ~ 150 mA
- Equivalent Full Range Temperature Coefficient of 50PPM/℃
- Temperature Compensated For Operation Over Full Rate Operating Temperature Range
- Low Output Noise Voltage
- Fast Turn-on Response
- TO-92, SOT-89 or SOT-23 3L Package

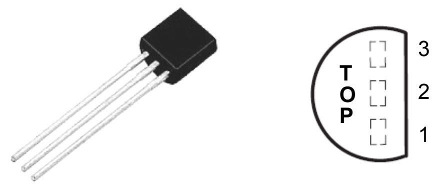
APPLICATION

- Shunt Regulator
- Precision High-Current Series Regulator
- High-Current Shunt Regulator
- Crowbar Circuit
- PWM Converter With Reference
- Voltage Monitor
- Precision Current Limiter

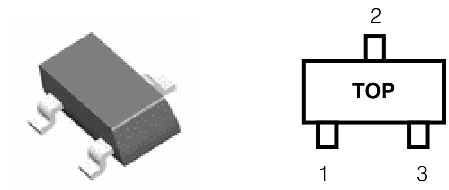
DESCRIPSION

The TL431 is a three-terminal adjustable shunt regulator with specified thermal stability over applicable temperature V_{REF} (Approx. 2.5V) and 40V with two external resistors. This device has a typical dynamic output impedance of 0.2Ω. Active output circuitry provides a very sharp turn-on characteristic, making this device excellent replacement for zener diodes in many applications. The TL431 is characterized for operation from -40℃ to +125℃.

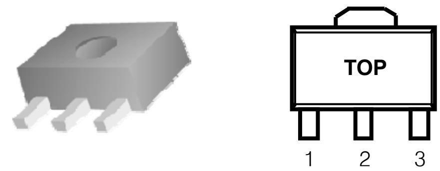
TO-92 PKG



SOT-23 PKG



SOT-89 PKG



PIN 1. Reference 2. Anode 3. Cathode

ORDERING INFORMATION

Device	Package
TL431	TO-92(Bulk)
TL431TA	TO-92(Taping)
TL431SF	SOT-23 3L
TL431F	SOT-89 3L

* Refer to the page 2 for detailed ordering Information,

Absolute Maximum Ratings

(Operating temperature range applies unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN.	MAX.	UNIT
Cathode Voltage	V_{KA}	-	42	V
Cathode Current Range(Continuous)	I_K	-100	150	mA
Reference Input Current Range	I_{REF}	-0.05	10	mA
Junction Temperature Range	T_J	-40	150	℃
Operating Temperature Range	T_{OPR}	-40	125	℃
Storage Temperature Range	T_{STG}	-65	150	℃

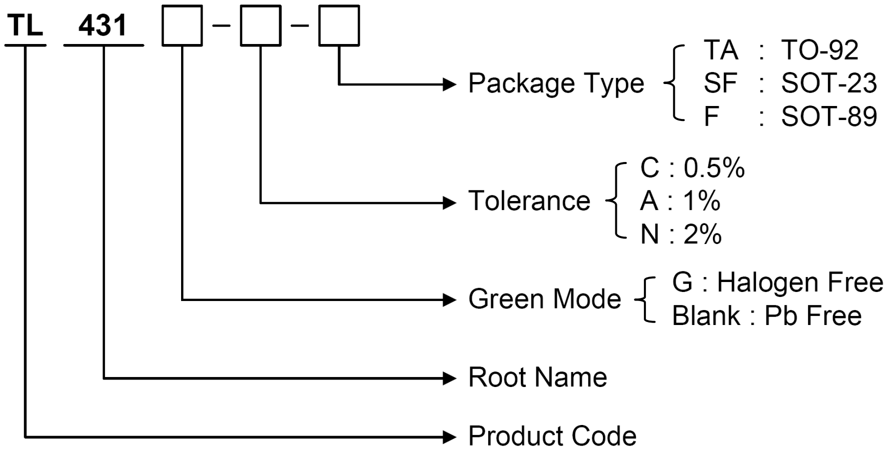
RECOMMENDED OPERATING CONDITIONS

CHARACTERISTIC	SYMBOL	MIN.	MAX.	UNIT
Cathode Voltage	V_{KA}	V_{REF}	40	V
Cathode Current	I_K	0.5	100	mA

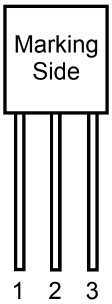
Ordering Information

V_{REF}	Package	Tolerance	Order No.	Package Marking	Supplied As
2.495V	TO-92	0.5%	TL431C	TL431-C	Bulk
			TL431GC	TL431GC	
			TL431CTA	TL431-C	Tape
			TL431GCTA	TL431GC	
		1%	TL431A	TL431-A	Bulk
			TL431GA	TL431GA	
			TL431ATA	TL431-A	Tape
			TL431GATA	TL431GA	
		2%	TL431	TL431	Bulk
			TL431G	TL431G	
			TL431TA	TL431	Tape
			TL431GTA	TL431G	
	SOT-23	0.5%	TL431CSF	431	Reel
			TL431GCSF	431	
		1%	TL431ASF	431	Reel
			TL431GASF	431	
		2%	TL431SF	431	Reel
			TL431GSF	431	
	SOT-89	0.5%	TL431CF	431	Reel
		1%	TL431AF	431	Reel
		2%	TL431F	431	Reel

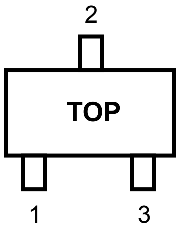
Ordering Information (continued)



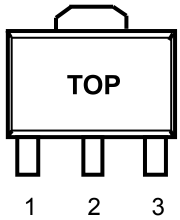
PIN CONFIGURATION



TO-92 PKG



SOT-23 PKG



SOT-89 PKG

PIN DESCRIPTION

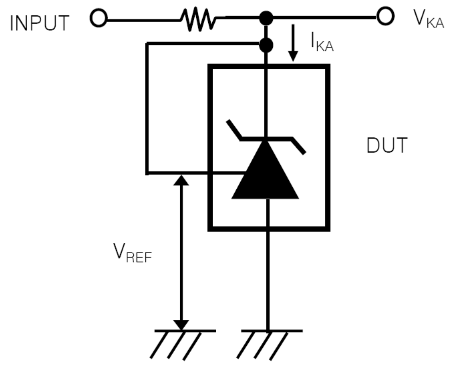
Pin No.	TO-92 / SOT-23 / SOT-89	
	Name	Function
1	Reference	Reference Voltage
2	Anode	Ground
3	Cathode	Input Supply Voltage

TL431 ELECTRICAL CHARACTERISTICS

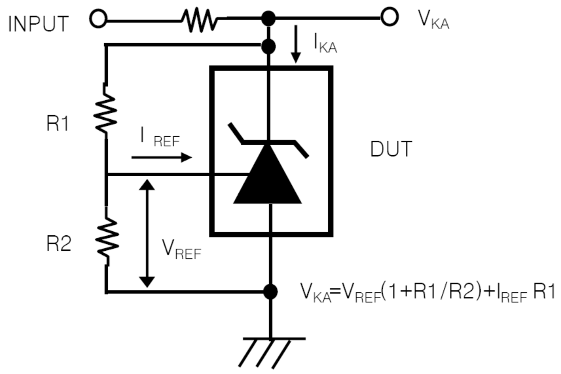
(T_A=25℃, unless otherwise specified)

CHARACTERISTIC	SYMBOL	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
Reference Input Voltage	V_{REF}	V_{KA} =V_{REF}, I_K =10mA	TL431C	2.483	2.495	2.507	V
			TL431A	2.470	2.495	2.520	
			TL431	2.440	2.495	2.550	
Deviation of Reference Input Voltage	$\Delta V_{REF}/\Delta T$	V_{KA} = V_{REF}, I_K =10mA T_A =Full Range			8	20	mV
Ratio of Change in Reference Input Voltage to the Change in Cathode Voltage	$\Delta V_{REF}/\Delta V_{KA}$	I_K =10mA	ΔV_{KA}=10V -V_{REF}		-1.4	-2.7	mV/V
			ΔV_{KA}=36V-10V		-1.0	-2.0	
Reference Input Current	I_{REF}	I_{KA}=10mA, R_1=10kΩ, R_2=∞			1.8	4.0	uA
Deviation of Reference Input Current	$\Delta I_{REF}/\Delta T$	I_K =10mA, R_1=10kΩ, R_2=∞ T_A =Full Range			0.4	1.2	uA
Minimum Cathode Current for Regulation	$I_{K(MIN)}$	V_{KA}= V_{REF}				0.5	mA
Off-State Cathode Current	$I_{K(OFF)}$	V_{KA}=36V, V_{REF}=0			0.17	0.90	uA
Dynamic Impedance	Z_{KA}	V_{KA}= V_{REF}, I_K =1mA~100mA f ≤ 1kHz			0.27	0.50	Ω

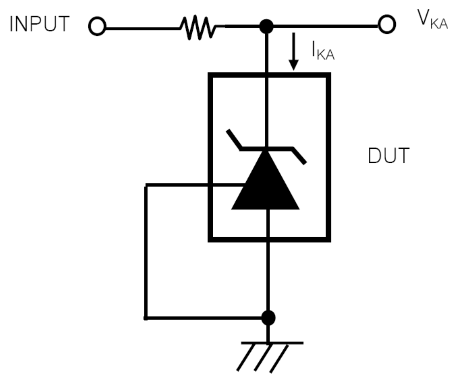
TEST CIRCUITS



< Fig 1. Test circuit for $V_{KA} = V_{REF}$ >



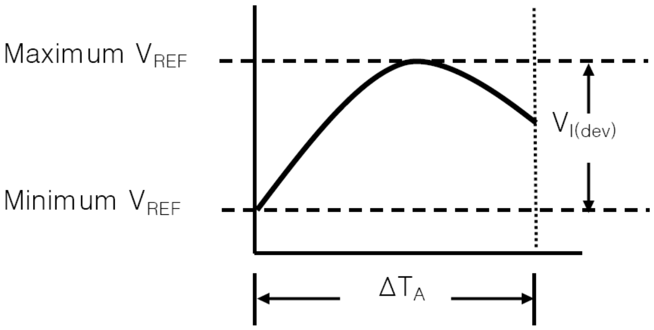
< Fig 2. Test circuit for $V_{KA} \geq V_{REF}$ >



< Fig 3. Test circuit for $I_{KA(OFF)}$ >

The deviation parameters $\Delta V_{REF}/\Delta T$ and $\Delta I_{REF}/\Delta T$ are defined as the differences between the maximum and minimum values obtained over the recommended temperature range. The average full-range temperature coefficient of the reference voltage, αV_{REF}, is defined as :

$$\left|\alpha V_{REF}\right|(ppm/℃) = \frac{\left(\frac{V_{I(dev)}}{V_{REF}\ at\ 25℃}\right)\times 10^6}{\Delta T_A}$$



Where :

ΔT_A is the recommended operating free-air temperature range of the device.

αV_{REF} can be positive or negative, depending on whether minimum V_{REF} or maximum V_{REF}, respectively, occurs at the lower temperature.

Example : Maximum V_{REF}=2496mV at 30℃, maximum V_{REF}=2492mV at 0℃, V_{REF}=2495mV at 25℃, ΔT_A=70℃ for TL431C.

$$\left|\alpha V_{REF}\right| = \frac{\left(\frac{4mV}{2495mV}\right)\times 10^6}{70℃} \approx 23ppm/℃$$

Because minimum V_{REF} occurs at the lower temperature, the coefficient is positive.

Calculating Dynamic Impedance

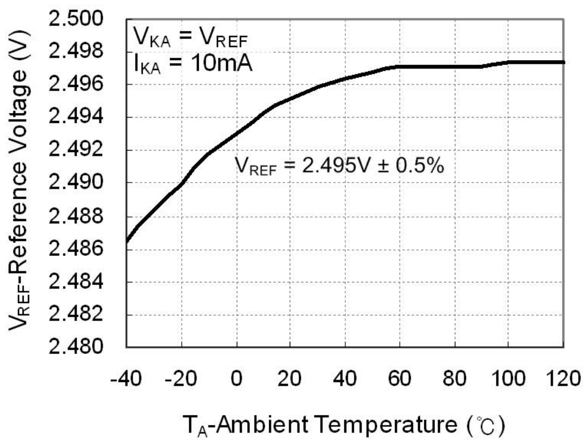
The dynamic impedance is defined as : $\left|Z_{KA}\right| = \frac{\Delta V_{KA}}{\Delta I_{KA}}$

When the device is operating with two external resistors, the total dynamic impedance of the circuit is given by:

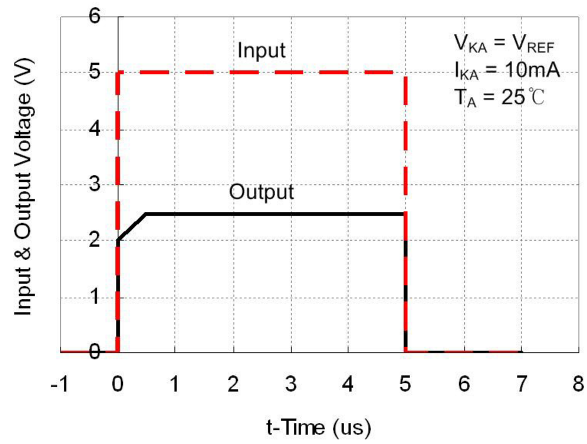
$$\left|Z'\right| = \frac{\Delta V}{\Delta I} \approx \left|Z_{KA}\right|(1 + R1/R2)$$

TYPICAL OPERATING CHARACTERISTICS

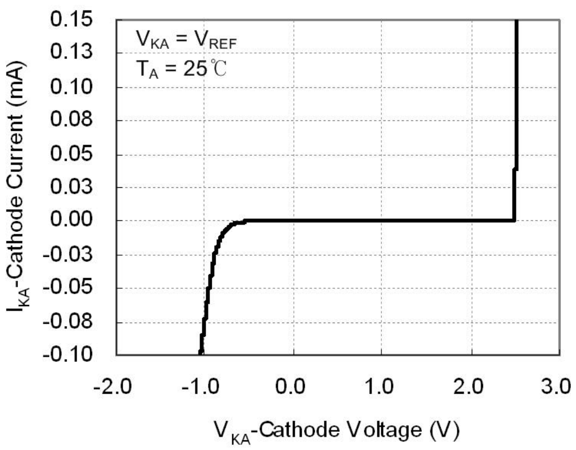
Reference Voltage vs. Ambient Temperature



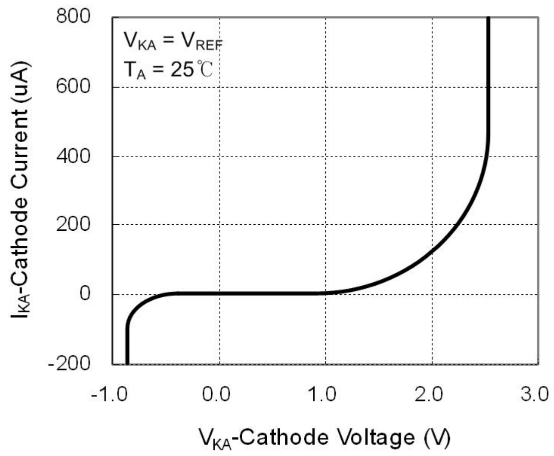
Pulse Response



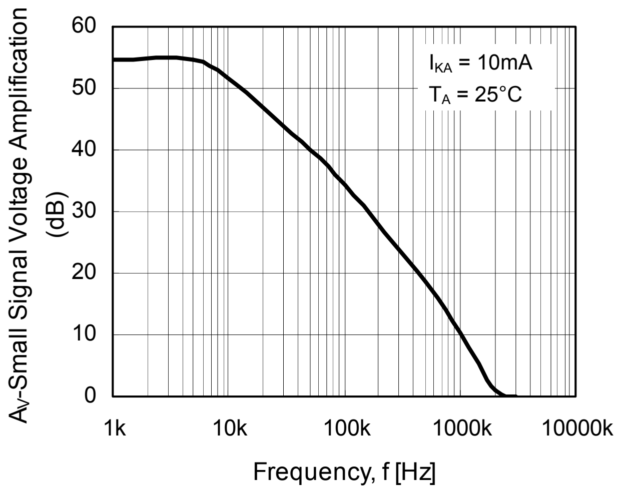
Cathode Current vs. Cathode Voltage

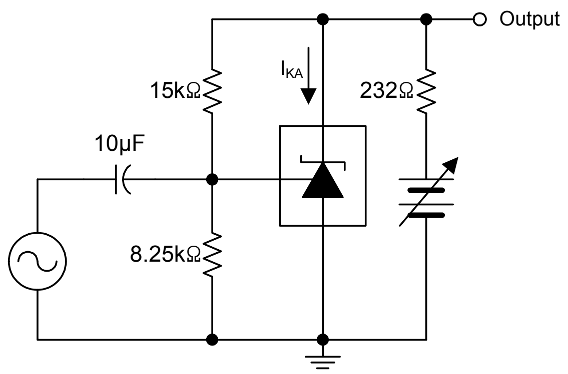


Cathode Current vs. Cathode Voltage



Small Signal Voltage Amplification vs. Frequency

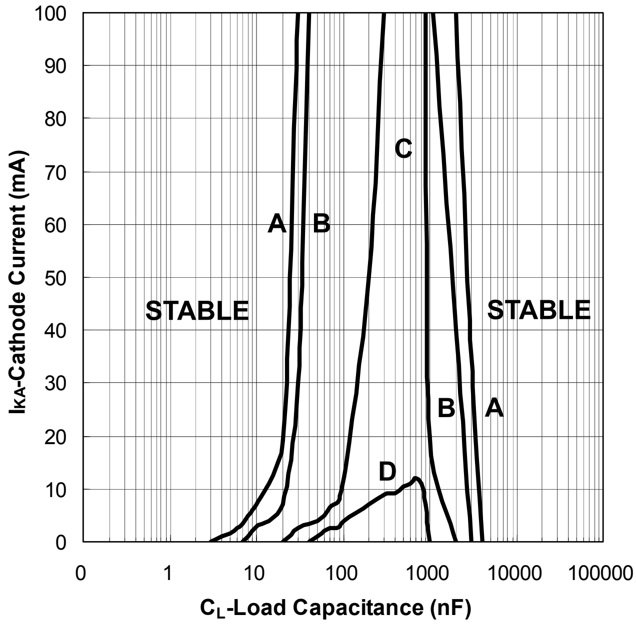


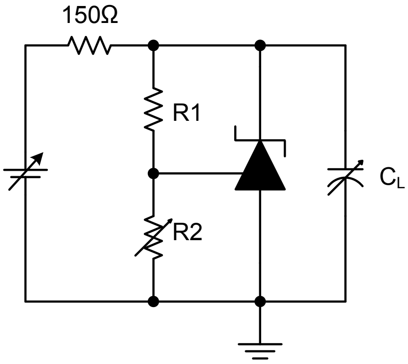


< Fig 4. TEST Circuit for Voltage Amplification >

TYPICAL OPERATING CHARACTERISTICS (continued)

Stability Boundary Conditions



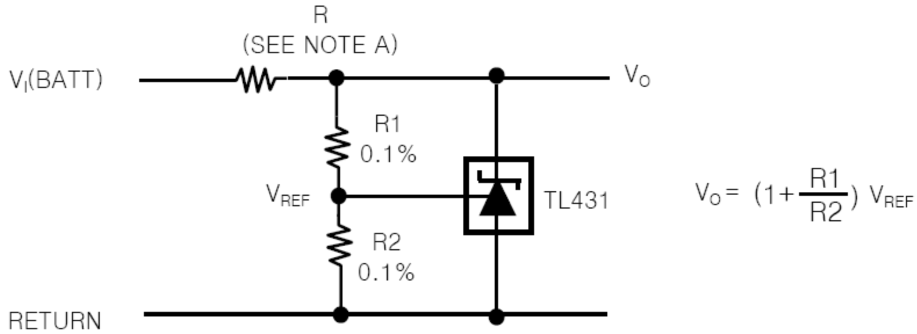


< Fig 5. TEST Circuit >

A $V_{KA} = V_{REF}$, R1= 0Ω, R2 = ∞
B V_{KA} = 5.0V, R1=10kΩ, R2 = 10kΩ
C V_{KA} = 10.0V, R1=10kΩ, R2 = 3.3kΩ
D V_{KA} = 15.0V, R1=10kΩ, R2 = 2KΩ

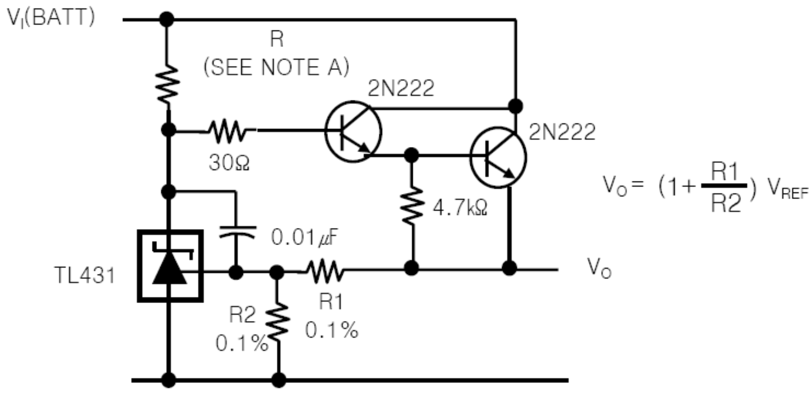
APPLICATION INFORMATION

1. Shunt Regulator



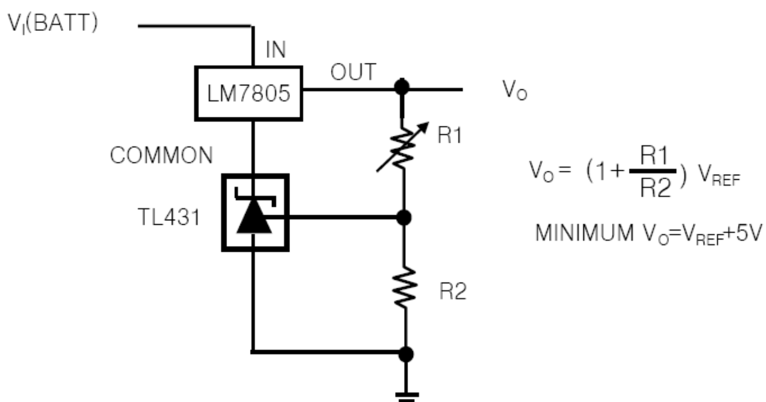
Note A : R Should provide cathode current 1mA to the TL431 at minimum $V_{I(BATT)}$

2. Precision High-Current Series Regulator

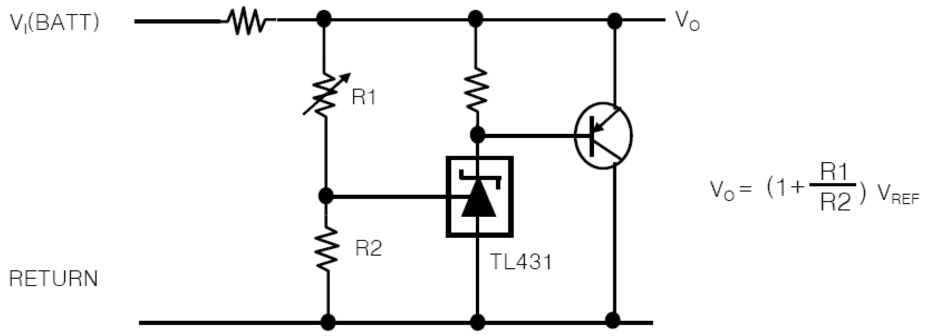


Note A : R Should provide cathode current≥1mA to the TL431 at minimum $V_{I(BATT)}$

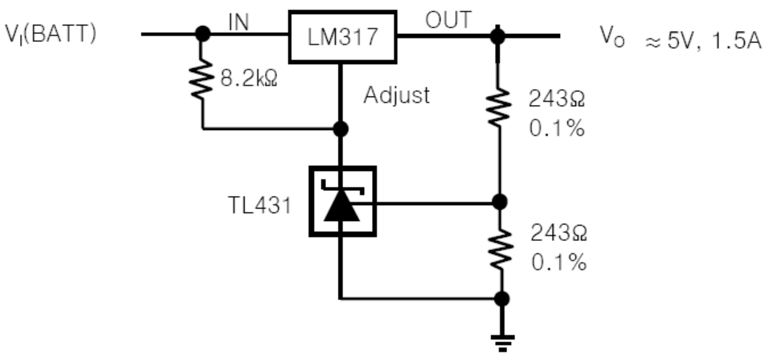
3. Output Control of a Three-Terminal Fixed Regulator



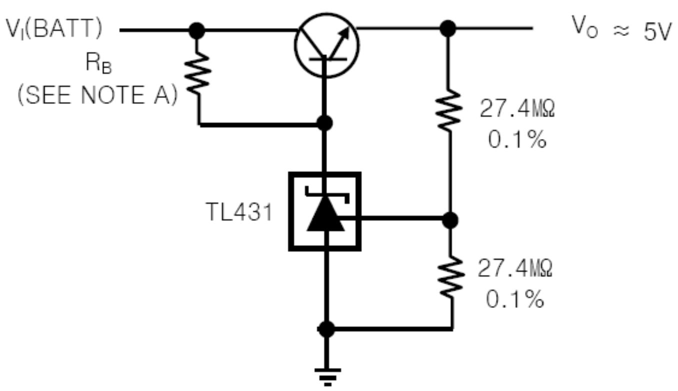
4. **High-Current Shunt Regulator**



5. **Precision 5-V 1.5A Regulator**

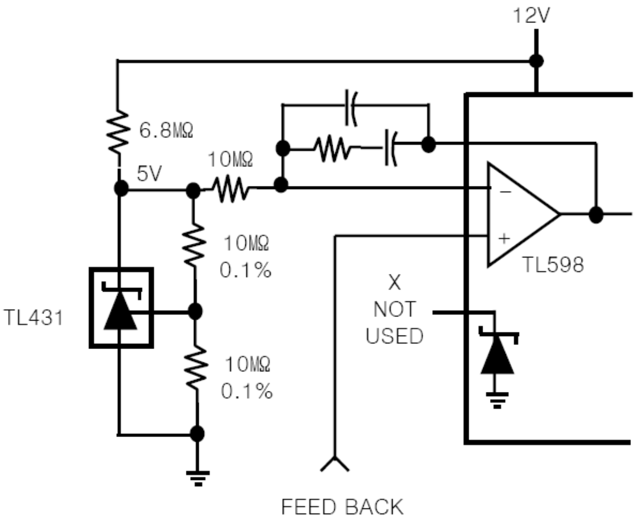


6. **Efficient 5-V Precision Regulator**

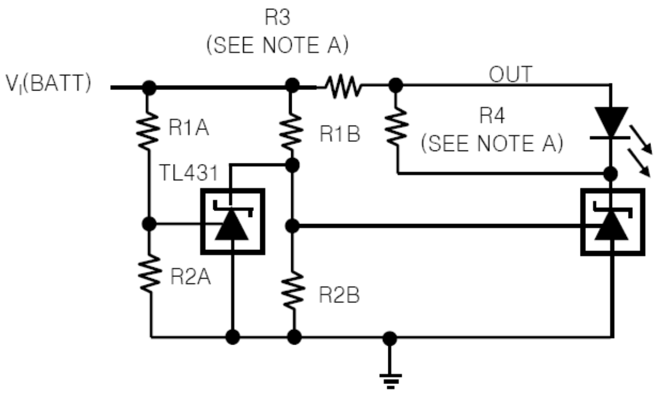


NOTE A : R_B Should provide cathode current≥1mA to the TL431.

7. PWM Converter With Reference



8. Voltage Monitor



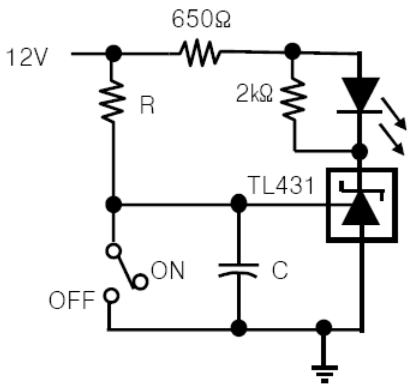
$$\text{LOW LIMIT} = \left(1+\frac{R1B}{R2B}\right) V_{REF}$$

$$\text{HIGH LIMIT} = \left(1+\frac{R1A}{R2A}\right) V_{REF}$$

LED ON WHEN LOW LIMIT < $V_{I(BATT)}$ < HIGH LIMIT

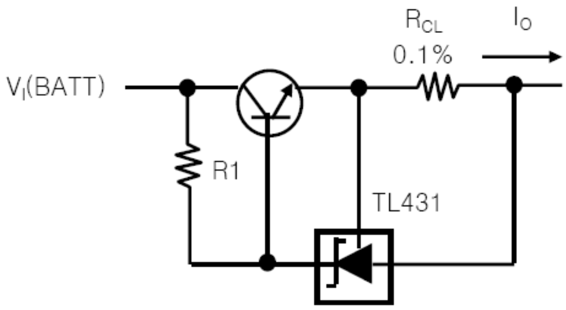
NOTE A : R3 and R4 are selected to provide the desired LED intensity and cathode current ≥1mA to the TL431 at the available $V_{I(BATT)}$.

9. Delay Timer



$$\text{DELAY} = R \times C \times I_N \left(\frac{12V}{12V - V_{REF}}\right)$$

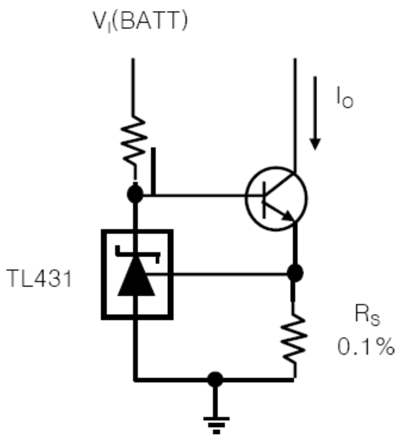
10. Precision Current Limiter



$$I_{OUT} = \frac{V_{REF}}{R_{CL}} + I_{KA}$$

$$R1 = \frac{V_{I(BATT)}}{\frac{I_O}{H_{FE}}} + I_{KA}$$

11. Precision Constant-Current Sink



$$I_O = \frac{V_{REF}}{R_S}$$